The plant population of northern lower Michigan and its environment

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(WITH THREE TEXT FIGURES)

Introduction.—The northern third of the Lower Peninsula of Michigan, an area of about 11,000 square miles, seems to differ from all other parts of the United States sufficiently to be treated as a distinct geographical region. Its most striking characteristic is probably the prevailing sandiness of the soils. (In this particular, as well as in the abundance of lakes, swamps and bogs, it reminds one strongly of Florida.) It differs further from the Upper Peninsula, the nearest land to the northward, in being warmer and therefore in having less of the boreal conifer element in its forests, and from the territory adjoining it on the south in being colder and in having a somewhat different seasonal distribution of rainfall (as will be pointed out farther on) and more swamps.

The southern boundary is very indefinite, but may be located arbitrarily for statistical purposes at the parallel of latitude 44° 15′, which crosses the state from near the mouth of the Manistee River to the mouth of Saginaw Bay, and passes through or near Manistee, Cadillac, and Tawas City. Only about one sixth of the area is under cultivation, so that there is no lack of vegetation to study. But as the lumbermen spoiled the looks of the country before there were many botanists in Michigan, and nearly all the plants happen to belong to widely distributed species, comparatively few botanical explorers have investigated this region. Aside from incidental references in Cowles's well-known monograph on the dunes of Lake Michigan (1899), Beal's Michigan Flora (1904), and a few local plant lists, the following seem to be about the only easily accessible papers on this region that a phytogeographer would need to consult. Some of them contain references to earlier literature of some importance. The arrangement is chronological.

V. M. Spalding. "The Plains" of Michigan. Am. Nat. **17**: 249–259. 1883.

C. S. Sargent. (Forests of) Michigan. Tenth Census U. S. **9**: 550–554. 1884.

R. C. Kedzie. The jack pine plains. Mich. Exp. Sta. Bull. 37. 8 pp. 1888.

S. M. Coulter. An ecological comparison of some typical swamp areas. Rep. Mo. Bot. Gard. **15**: 38–71. *pl. 1–24.* 1904. (See pp. 41–49 for Michigan.)

B. E. Livingston. The relation of soils to natural vegetation in Roscommon and Crawford Counties, Michigan. Bot. Gaz. **39**: 22–41, with map. Jan. 1905. Also in Rep. Mich. Geol. Surv. **1903**: 9–30. *pl. 3.*

H. H. Rusby. Observations in economic botany at Oscoda, Michigan. Jour. N. Y. Bot. Gard. **7**: 211–213. Sept. 1906.

W. J. Geib. Soil survey of Wexford County, Michigan. Field Operations U. S. Bur. Soils **1908**: 1051–1066. 1911. (Advance copies, separately paged, distributed in October, 1909.)

E. S. Whitaker. A vacation in northern Michigan. Forest & Stream **77**: 806–807. Dec. 2, 1911.

Hu Maxwell. Wood-using industries of Michigan. (State publication, no series or number.) 101 pp., 2 folded tables. Lansing, 1912. (The notes on this region are mostly on pp. 7–10. See criticism in Proc. Soc. Am. Foresters **11**: 350. 1916.)

Frank Leverett. Surface geology and agricultural conditions of the southern peninsula of Michigan. (With a chapter on climate by C. F. Schneider.) Mich. Geol. & Biol. Surv. Publ. 9 (Geol. Series 7). 144 pp., 15 plates (including 3 folded maps), 16 figs. 1912.

F. C. Gates. The vegetation of the region in the vicinity of Douglas Lake, Cheboygan County, Michigan, 1911. Rep. Mich. Acad. Sci. **14**: 46–106, with 24 half-tones on 17 plates. 1913.

H. A. Gleason & F. T. McFarland. The introduced vegetation in the vicinity of Douglas Lake, Michigan. Bull. Torrey Club **41**: 511–521. Oct. 1914.

F. C. Gates. The relation between evaporation and plant succession in a given area. Am. Jour. Bot. **4**: 161–178. *f. 1–9* (including 5 half-tones). March, 1917. (Area treated is in Cheboygan County, Michigan.)

H. A. Gleason. Some effects of excessive heat in northern Michigan. Torreya **17**; 176–178. Oct. 1917.

The plant population statistics given below are based on notes taken by the writer while occupying the post of research assistant in botany at the Biological Station of the University of Michigan in the summer of 1912. Most of the observations were made while walking out in all directions from the station (which is on Douglas Lake), as far as Cheboygan and Topinabee on the east and Pellston on the west. Copious notes were also taken from trains on the Michigan Central R. R. from Cheboygan to Mackinaw City, on the Grand Rapids & Indiana Ry. from Cadillac and Mackinaw City to Pellston, and on the Pere Marquette R. R. from Petoskey southward to the limits of the region and beyond.

Geology and soils.—The whole of lower Michigan is underlaid by nearly horizontal Paleozoic strata, largely limestones and shales of Devonian and Carboniferous age, but in the region under

consideration these are exposed only in limited areas near the Great Lakes, and have little influence on soil or topography. The interior is covered by glacial drift, averaging several hundred feet thick and composed of sand, clay, pebbles and small boulders in various proportions. The pebbles and boulders are quite diverse lithologically, but most of them are more or less calcareous. Few of the boulders are more than a foot or two in diameter, or large enough to support any characteristic vegetation.

There is only one government soil survey for this region as yet, and that is for one of the counties at its southern edge. But Leverett's bulletin, above cited, divides the soils of the Lower Peninsula into about half a dozen classes, and gives the approximate acreage of each in every township and county. From the returns from the twenty-one northernmost counties the following percentages have been computed; and the corresponding figures for the remaining forty-seven counties are given in an adjacent column for purposes of comparison.

Soil classes	Northern counties	Central and southern counties
Sandy till	26.9	21.0
Sand	25.9	24.7
Clayey till	18.6	38.2
Swamps and lakes	17.9	8.8
Gravelly loam	9.7	6.7
Gravel	1.0	0.5

The clayey till includes both moraines and glacial-lake deposits, which could have been separated if it had seemed worth while. (The latter type in Michigan is chiefly confined to the vicinity of Saginaw Bay and Lake Erie, and is very sparingly represented in the region under consideration). Some of the larger interior lakes are excluded from the estimate for swamps and lakes.

The sand on many of the uplands is so deep and loose as to make walking and hauling on unimproved roads somewhat difficult in dry weather, just as in many parts of Florida. No satisfactory chemical analyses of the soils seem to be available, but they are doubtless below the average in fertility.

Topography and hydrography.—The topography is that common to many glaciated regions, undulating to hilly, with numerous depressions containing lakes, ponds, swamps, bogs, marshes, etc. The largest lakes cover about thirty-five square miles. The highest

elevations are only about nine hundred feet above the Great Lakes, and are near the southern edge of the region, so that there are probably no differences in vegetation that can be ascribed to altitude alone. Several series of supposed ancient beaches, formed in glacial times when the Great Lakes were considerably higher than at present, have been traced by Leverett and others, but as in the case of the supposed marine Pleistocene terraces of Maryland and other Atlantic states,* these episodes of geological history seem to bear no obvious relation to the present vegetation, except as they may have locally influenced soil or topography. (In other words, the vegetation of an area that has been above the water say a hundred thousand years does not differ noticeably from that of one only ten thousand years old, if the soil is the same. And if the soil is not the same, that is a matter for the geologist to explain, not for the botanist.)

Being on a peninsula not exceeding a hundred and fifty miles in width, this region has no large rivers. The drainage area of the largest, the Cheboygan, covers about sixteen hundred square miles. On account of the absence of rock ledges there are no waterfalls, but in descending a few hundred feet from their sources to their mouths the rivers necessarily traverse some gravelly rapids, which are being utilized more and more for water-power. The presence of many lakes and swamps and the coincidence of the hottest season with the season of greatest precipitation makes the flow of all the streams pretty steady, and on account of the prevailing sandy soil and the scarcity of cultivated fields they carry very little sediment. (In these respects also this region resembles Florida more than it does most of the intervening states.)

Climate.—The average temperature is 41°–45° F., the January mean 18°–23°, and the July mean 66°–69°. The proximity of two of the Great Lakes presumably makes the difference between summer and winter climate a little less than it would be otherwise. The average growing season or period free from killing frosts is 125 to 145 days, the average annual snowfall about seventy inches, and the absolute minimum temperature about —40° F.

This is one of the driest parts of the eastern United States, having only about thirty inches of rain and melted snow annually.

* See Geog. Review **4**: 224–225. Sept. 1917.

An interesting feature of the precipitation is that late summer is the wettest season, by a small margin. In this particular our region resembles the pine-barren portions of the coastal plain, and differs notably from southern Michigan and the whole Mississippi valley, where spring and early summer are the rainy seasons. Coming as it does just when the evaporating power of the sun tends to be greatest, the late summer rain helps keep the ground-water level constant and favors the formation of peat. It may be a mere coincidence that two such sandy and peaty and "piney" and thinly settled regions as northern Michigan and peninsular Florida should both have a late summer rainy season, but it is more than likely that the rainfall has influenced the soil somewhat, or even *vice versa* through the vegetation, for there is no apparent physiographic reason why the seasonal distribution of rain should be any different in Michigan from what it is in Ohio and Indiana, for example.

Vegetation.—The aspects of the vegetation or the composition of the plant associations have been described at considerable length in some of the papers cited, particularly those by Livingston and Gates (and Gates's are illustrated), so that it is not necessary to say much more on the subject here, except for pointing out some fundamental principles often overlooked, and giving quantitative data, which have not been supplied before except for very small areas or for only a few species.

The dry uplands have vegetation of three principal types, correlated with soil differences. On the more clayey soils the original forests evidently were mainly of hardwoods and hemlock, making a dense shade and considerable humus. On the most sterile sands forests of jack pine prevail,* while in intermediate habitats, covering most of the upland area, white and red pines seem to have been the dominant trees before the lumbermen appeared on the scene.

The streams have more or less meadow and river-bank vegetation along them, but few species seem to be confined to such situations in the region under consideration. Flat areas adjacent

* See Spalding's paper on "The Plains" previously referred to, and Beal's Michigan Flora, pp. 16–18. The jack pine, *Pinus Banksiana*, resembles the Florida spruce pine, *P. clausa*, very much in general appearance, habitat, and relations to fire. (See Ann. Rep. Fla. Geol. Surv. 7: 142–144, 155. 1915.)

to streams and lakes, with a slow circulation of water through the muck or peat, are generally densely wooded with spindle-shaped, short-leaved conifers of the type characteristic of snowy climates.*

FIG. 1. Peat bog in a small sandy depression close to south shore of Douglas Lake, but apparently quite independent of the lake. Water deep and cool and not subject to much fluctuation. The floating leaves are *Nymphaea variegata*. Bog vegetation of the common slow-growing "high moor" or muskeg type, or the *Chamaedaphne* association of Gates (1913, p. 57); mostly evergreen. The trees are *Picea mariana* and *Larix*, and the shrubs mostly *Chamaedaphne*, *Nemopanthes*, *Andromeda*, and *Kalmia polifolia*. Herbs are relatively inconspicuous, but there is an abundance of sphagnum. (This is one of the few known localities in Michigan for *Razoumofskya pusilla*, which is parasitic on the spruces.)

The basin-like depressions, which may or may not have visible outlets, have quite a variety of vegetation, depending on their size, depth, etc. The larger ones contain lakes, with little vegetation in their deeper parts, many characteristic aquatics in sheltered shallow bays, and still other species, mainly of rush-like aspect, on wave-washed sandy beaches. Around the lakes are also numerous lagoons cut off by barrier beaches, and these commonly contain marsh vegetation, composed largely of grasses, sedges and rushes. The isolated depressions which are too small for wave action are usually occupied, at least around their edges,

* See Pop. Sci. Monthly **85**: 340–341. 1914.

by either marsh or bog vegetation (corresponding to Warming's "low moor" and "high moor" respectively.*)

The most significant difference between marsh and bog vegetation (and one apparently overlooked by Warming in contrasting his low and high moors) is in the rate of growth; and just why rank grasses should occupy one pond and the slow-growing sphagnum, evergreen shrubs, and stunted conifers another has never been fully explained. The depth of the water undoubtedly has a great deal to do with it, for a shallow pond is quickly warmed by

FIG. 2. Looking north across a shallow marsh or sedgy pond, with stagnant water quite warm in summer, a sort of "low moor", 20–25 acres in extent, about 2 miles southeast of Douglas Lake. Vegetation mostly *Carex filiformis*, with a few island-like patches of *Chamaedaphne* and *Andromeda*. Partly burned conifer swamp in background. (A little to the left of this view, near a moderately rich hillside, was some ranker and therefore faster-growing vegetation, including *Calamagrostis canadensis*, *Typa latifolia*, *Sparganium*, and *Iris versicolor*.)

the sun, and one in Michigan, where the sun shines nearly sixteen hours a day in midsummer, may be nearly as warm during the growing season as one in Florida, where there is not more than fourteen hours of sun in a day. Furthermore, a deep pond, besides being colder, may be too deep in the middle for aquatic plants rooted in the soil (such as the Nymphaeaceae) to reach the surface, so that it

* See his Oecology of Plants (1909), pp. 196–199, 200–205.

can be filled only by means of a floating mat of vegetation growing out from the edges.* And plants not connected with the soil, whether epiphytic or floating, cannot grow very fast on account of the dearth of mineral plant food. The peculiarities of bog vegetation have been commonly attributed to the acidity of the water, but the acids in bog water are not a fundamental part of the environment, but are derived from the vegetation, so that offering such an explanation is only reasoning in a circle.†

The size of the basin in which the pond or bog is located also influences the vegetation through the amount of seasonal fluctuation of water (as was observed in Florida a few years ago‡). For considerable fluctuation of water in or above the ground hastens the decay of dead vegetation and the liberation of the food in it, and peat is formed best in places where the water-level is nearly constant.§

The occurrence of typical slow-growing (sometimes erroneously called xerophytic) bog vegetation in flat, slowly drained areas as well as in deep stagnant basins is probably to be explained largely by the fact that seeping water, having just emerged from the ground, is considerably cooler in summer than shallow standing water.|| The dense growth of conifers in such places still further protects the water from the heat of the sun, after they are once established. Another important factor is that in a perpetually saturated soil the lack of aëration restricts the availability of the mineral plant food in the soil, particularly the potassium compounds. Of course it may be said that the soil of a marsh is also perpetually saturated, which is true enough; but in a marsh, whether stagnant or estuarine, the water has been exposed to evaporation much longer than that in a seepage or spring-fed swamp, and thus the soluble salts in it are more concentrated.

* Probably the best description of this process is that by C. A. Davis in Rep. Mich. Geol. Surv. **1906**: 125–172. 1907.

† For a summary of bog theories, in which however the question of mineral nutrients is hardly considered at all, see G. B. Rigg, Plant World **19**: 310–325. "Oct." [Nov.], 1916.

‡ See Torreya **11**: 225–234. 1911; Ann. Rep. Fla. Geol. Surv. **6**: 202, 203. *figs. 46–48*. 1914.

§ See Ann. Rep. Fla. Geol. Surv. **3**: 211. 1911.

|| The temperature of springs, other than thermal springs, is usually very close to the average annual temperature of the locality where they occur.

Furthermore, most marsh plants have hollow or spongy stems or petioles, or aerenchyma, or pneumatophores, all of which doubtless serve to conduct air to the roots.

It might be observed here, parenthetically, that many plants which in the region under consideration are chiefly confined to bogs grow equally well on uplands in colder climates.* This is probably because the low temperature and short growing season farther north so limit the availability of the nutrients in the soil that none but slow-growing plants can thrive.

An elaborate system of hypotheses of succession has been postulated by Gates and others who have worked in this or somewhat similar regions, and some have even gone so far as to try to connect all the plant associations in a limited area by successional relations. But some of the imagined successions can never take place without profound topographic changes, which may or may not come to pass, and with which the botanist is not particularly concerned. There are, however, two genuine types of succession (biotic succession as defined by Cowles,† and distinguished from his regional and topographic successions) which can be studied to advantage in this region. The first is that connected with the filling of lakes, etc., with vegetation and the gradual accumulation of peat and humus. In a coniferous swamp the falling leaves, twigs, trunks, etc., gradually pile up high enough above the groundwater level to be subject to ordinary decay, and thus form humus or duff instead of true peat. In such humus grow many plants which are equally characteristic of the upland hardwood forests, and this has led some to believe that the swamps, barring human interference and unforeseen complications, will ultimately be replaced by beech-maple-hemlock forests. But there are quite a number of plants in this region which seem to demand both humus and access to mineral soil or alkaline peat, such as *Acer saccharum*, *Tsuga*, *Fagus*, *Tilia*, *Ulmus*, *Quercus alba*, *Viburnum acerifolium*, *Vagnera racemosa*, *Carex arctata*, *C. laxiflora*, *Washingtonia*, *Actaea alba*, *Circaea*, *Adiantum pedatum*, *Geranium Robertianum*, *Caulophyllum*, and several others less common here, and we have no

* See Livingston, Bot. Gaz. **39**: 40. 1905; Harper, Pop. Sci. Monthly **85**: 340. 1914.

† Bot. Gaz. **51**: 161–183. 1911.

evidence that these will ever grow on top of deep sour peat. Furthermore, the swamps are colder at night than the adjoining slopes, and lack some of the characteristic soil fauna of clayey uplands, and these fundamental differences can hardly be obliterated by succession.

It has been assumed also that the pine forests on the sandy uplands would likewise be succeeded by hardwood forests, if fire and lumbering did not prevent the accumulation of humus. Although the sand is undoubtedly poorer than the clay, one might suppose that in the course of centuries the pines could bring up enough mineral matter from a depth of several feet, and deposit it on the surface in decaying leaves, to make a rich soil that would support trees that make a complete new crop of leaves every year, and that such a forest when once established would be self-perpetuating, as it would return to the soil every fall what it took up in the spring and summer. But the difficulty is that in sandy soils leaching probably goes on fast enough to prevent the accumulation of any considerable amount of plant food on the surface of the ground. (On clayey slopes there is less leaching, and erosion is constantly exposing fresh layers of soil, and thus maintaining its fertility indefinitely.) It seems that in many if not most cases the proportion of deciduous trees in a forest does not increase with succession, but depends on fundamental soil characters.*

Another type of succession is a periodic one resulting from fire. In a state of nature the hardwood forests were rarely visited by fire, and one might say figuratively that the plants in such habitats made no provision for such an occurrence. The pine forests have been so nearly destroyed that it is difficult to determine what the normal frequency of fire in them may have been. As *Pinus resinosa* is not very sensitive, it may have been subject to ground-fires every few years, like some of the southeastern pines;† while in the white-pine forests fire may have been almost as rare as in the hardwoods. Be that as it may, the "pernicious activities" of the lumbermen a few decades ago removed the greater part of these two valuable pines,‡ and the ground formerly occupied by

* See H. W. Wiley, Science II. **17**: 794–795. May 15, 1903; Harper, Bull. Torrey Club **41**: 209–220. 1914; B. Moore, Bot. Gaz. **61**: 59–66. Jan. 1916.

† See Pop. Sci. Monthly **85**: 343. 1914.

‡ The effects of lumbering in this part of Michigan have been described by several

them has now a low scrubby growth of birch and aspen, which is burned too often for the white pine to reëstablish itself, though the red pine is making some headway.

On steep bluffs and small islands, and in ravines, where fire is necessarily rare, we find some plants that are sensitive to fire but do not require as rich a soil as that of the hardwood forests, such as the few woody vines of the region. (Most of the existing white pines are found in such places, too.) The low sandy "ice ramparts" around the larger lakes are protected from fire on one side by the water and at the same time are too sterile to support vegetation dense enough to carry fire readily, so that certain fire-sensitive (or *pyrophobic*, if one may coin a new term) plants, such as *Amelanchier* sp., *Prunus pumila*,* *Rosa* sp., *Rhus Toxicodendron*, *Arctostaphylos Uva-ursi*, *Equisetum hyemale*, *Elymus* sp., and *Potentilla Anserina*, are characteristic of such places.

The normal frequency of fire in the jack-pine and spruce types of forest seems to be about once in the average lifetime of a tree. *Pinus Banksiana* is one of several pines whose cones remain closed and attached to the tree for many years, but open soon after a fire and discharge their seeds, thus re-stocking the forest. In the spruce bogs, as in the white-pine forests, one of the first effects of a fire sweeping through the crowns of the trees is to liberate the potash and other mineral substances stored up in several years' growth of leaves and twigs, which falls to the ground and acts as a high-grade fertilizer. Several quick-growing and short-lived trees and shrubs, such as *Betula*, *Populus tremuloides*, *P. grandidentata*, *Prunus pennsylvanica*, and a few characteristic herbs, known collectively as fire-weeds, soon invade the burned areas by means of seeds carried by wind or birds, and flourish until the surplus potash, etc., is exhausted. In the swamps one of the conifers itself, namely the deciduous one, *Larix*, acts as a sort of fireweed, being especially common in the first few decades after a fire; and its career is commonly terminated by saw-flies instead of fire. As it renews its whole crop of leaves every year it needs a larger food supply than the spruces, and it also extends farther into the

of the writers cited in the bibliography, particularly Dr. Rusby. Dr. H. A. Gleason told me in 1912 that he did not know of a single acre of virgin white-pine forest in lower Michigan.

* See Rhodora **18**: 202. Sept. 1916.

richer regions of southern Michigan, Ohio, etc., than they do. While the fireweeds are flourishing, seeds of the original conifers are being brought in in the regular manner, and by the time the birches and aspens have run their course the conifers that have

FIG. 3. Scene in large tamarack swamp with a few feet of peat, about four miles north of Douglas Lake, bordering a sluggish stream flowing into Carp Lake. Trees in background all or nearly all *Larix laricina*. (See Gates, 1913, pp. 64–66.) Open space in foreground evidently severely burned several years before. Woody plants in it mostly *Larix* seedlings, *Salix pedicellaris*, *Betula pumila*, *Rhamnus alnifolia*, *Chamaedaphne*, *Alnus*, *Lonicera canadensis* and *Ledum*. Evergreens in the minority; little or no sphagnum. (This view was taken a mile or more from the stream, and near the south edge of the swamp, where it is bordered by clayey hills mostly cultivated. Toward the stream the percentage of evergreens increases considerably.)

been growing up in their shade may be ready to dominate the situation again.*

Since the best pines have disappeared the lumbermen have attacked the hardwood forests also, and much hemlock has been destroyed for tan-bark. The slash left from these operations is subject to fire too, but the fireweeds on hardwood land are not quite the same as on pine land. *Sambucus pubens* and *Rubus* spp.

* So many papers have been written about the effects of fire in boreal coniferous forests that it would not be worth while to attempt to cite them here, but references to several of them can be found in Bull. Torrey Club **35**: 349. 1908, and in Pop. Sci. Monthly **85**: 341. 1914.

are quite characteristic, and the vacciniums are rare or absent. A hardwood area after logging, and even after the slash is burned, is very disagreeable to traverse, on account of the numerous logs and tops cumbering the ground, many of the logs being held up by stiff branches at such a height that it is just as hard to climb over them as to crawl under them, and only the smaller branches are consumed by fire, the larger ones making veritable *chevaux-de-frise* that last for many years. (Ten or twelve degrees farther south fallen trees decay much more rapidly, and do not materially impede the explorer after two or three years.*)

Farmers have damaged the vegetation still further by totally eradicating much of it to make room for crops. This influence has been chiefly concentrated on the hardwood land, on account of its richer soil, but only about 17 per cent. of the area was classed as "improved land" in 1910. The extension of farms ought to have one indirect beneficial effect on the pine land, however, by multiplying the barriers to fire and thus diminishing its frequency at any one point.†

Plant census.—The following plant list is based on the writer's observations in northern lower Michigan between June 28 and August 24, 1912. Although only nine of the twenty-one counties were visited in that time, the results are probably representative enough, except for the dunes and cliffs along the Great Lakes, which were not examined. The relative abundance of the species has been determined in the manner explained in several previous papers which are easily accessible.‡ Although some may question the accuracy of my rapid reconnoissance methods, there is probably no one at the present time in a position to assert that the results

* In this connection see W. H. Long, Investigations of the rotting of slash in Arkansas. U. S. Dept. Agr. Bull. 496. Feb. 1917.

Curiously enough, however, twenty degrees farther south the tropical hardwood forests of extreme southern Florida are subject to fire at long intervals, followed by a few characteristic fireweeds (*Trema*, *Carica*, etc.), and are just as disagreeable to traverse for some time afterward as these Michigan forests, on account of the hardness and durability of the wood of many of the trees.

† For an interesting account of the effects of farming on fire frequency in the Ozarks, see Marbut, Field Operations U. S. Bur. Soils **1911**: 1740. 1914. (Or page 20 of the separates.)

‡ Ann. Rep. Fla. Geol. Surv. **6**: 177–180. 1914; Bull. Torrey Club **41**: 557–559. 1914; **44**: 47–50. 1917; Torreya **17**: 1–2, 5–6. 1917.

are incorrect. Future explorations will doubtless necessitate changing the sequence of many of the species remote from the head of the list; but as it is, the present sequence corresponds very well with what one might obtain by counting the number of times each species is mentioned in previous descriptions of the vegetation of the same region.

The species are first divided into large trees, small trees, vines and large shrubs, small shrubs, and herbs. Large trees are large enough to be sawn into lumber, small trees large enough for posts, large shrubs for canes or bean-poles, and so on down. Woody vines are combined with large shrubs, because otherwise in the absence of numbers there would be nothing to indicate how relatively scarce they are, but their names are italicized to distinguish them. Some small evergreen plants which have perennial stems above the ground, such as *Equisetum* spp., *Lycopodium*, *Chimaphila*, *Gaultheria*, *Epigaea*, *Chiogenes*, *Oxycoccus*, *Mitchella*, and *Linnaea* (the "chamaephyte" class of Raunkiaer, in part), are classed with the herbs on account of their small size and lack of true woody tissue.

Evergreens are indicated by heavier type, as usual, and the names of weeds enclosed in parentheses, whether they are treated as exotics in the manuals or not.* The three commonest modes of dissemination are indicated by somewhat arbitrary but suggestive symbols, as follows: wind-borne seeds, Y; fleshy fruits, O; barbed fruits, X. It would have been interesting to indicate annuals, biennials, perennials, etc.† (or better still perhaps the Raunkiaerian growth-forms‡), as well as the blooming periods and color of flowers, but there are too many cases in which these data are not yet known accurately enough. The usual habitats of the different species are given in a few words.

In each major group the species are arranged as nearly as possible in order of present abundance. Very likely a similar census taken fifty years ago would have placed *Pinus Strobus* at the head of the list, and arranged some of the other trees differently, and excluded some of the weeds entirely. On account of

* See Bull. Torrey Club **35**: 347–360. 1908; **37**: 117–120. 1910.

† As in Ann. N. Y. Acad. Sci. **17**: 36–37. 1906, for example.

‡ For an easily accessible reference to Raunkiaer's system, and an illustration of its use, see Taylor, Am. Jour. Bot. **2**: 32. 1915.

the incompleteness of the data, and the great changes that have been made by lumbermen and others, percentage numbers are not attempted. But the numbers when finally determined probably will not depart much from a geometrical progression.* (The commonest herb, however, seems to be about four times as abundant as the next one.) The rarer species, and all cellular cryptogams, are omitted, because they make up such an insignificant part of the total vegetation.

TREES

Y	Larix laricina	Swamps and bogs
	Thuja occidentalis	" " "
Y	**Pinus Strobus**	Sandy uplands, etc.
Y	Acer saccharum	Rich uplands
Y	**Tsuga canadensis**	" "
	Fagus grandifolia	" "
Y	**Picea mariana**	Swamps and bogs
Y	**Abies balsamea**	" " "
Y	Acer rubrum	Various habitats
Y	Tilia americana	Rich uplands
Y	Fraxinus nigra	Swamps
Y	**Pinus resinosa**	Sandy uplands
Y	Ulmus americana	Richer soils
	Quercus borealis maxima†	Sandy uplands
Y	**Picea canadensis**	Swamps and bogs
Y	Betula lutea	Rich woods
Y	**Pinus Banksiana**	Poorest soils
	Quercus alba	Uplands
Y	Fraxinus americana	Richer soils

SMALL TREES

Y	Betula papyrifera	Various habitats
Y	Populus tremuloides	Burned areas mostly
Y	Populus grandidentata	" " "
O	Prunus pennsylvanica	" " "
Y	Populus balsamifera	Lake shores, etc.
	Ostrya virginiana	Rich uplands
Y	Salix fluviatilis?	Lake shores, etc.

LARGE SHRUBS AND VINES

	Alnus incana	Swamps, etc.
Y	Salix lucida	Wet places
Y	Salix spp‡	Swamps, etc.
Y	Acer pennsylvanicum	Rich woods

* See Torreya **13**: 244. Oct. 1913.

† Long known as *Q. rubra*. See Torreya **17**: 135. Aug. 1917.

‡ This includes several unidentified species. If they had been separated they would of course stand lower in the list.

O	Sambucus pubens	Burned or cleared hardwood land
O	Rhus sp.*	Burned uplands
O	Rhus glabra	" "
Y	Acer spicatum	Rich woods
O	Cornus stolonifera	Low grounds
O	Nemopanthes mucronata	Swamps
O	Ilex verticillata	Swamps
O	Amelanchier sp.	Various habitats
O	*Vitis vulpina*	Lake shores and bluffs
	Celastrus scandens	Bluffs and islands
O	Viburnum cassinoides	Swamps
Y	Salix discolor?	Low grounds

SMALLER SHRUBS

	Diervilla Lonicera	Sandy uplands
O	Rubus strigosus	Burned or cleared hardwood land
	Chamaedaphne calyculata	Open bogs
	Comptonia peregrina	Sandy uplands
O	Rubus allegheniensis?	Burns, clearings, etc.
O	Rhus Toxicodendron	Ice-ramparts, etc.
	Ledum groenlandicum	Bogs and swamps
Y	Salix rostrata?	Swamps
O	Vaccinium pennsylvanicum	Sandy uplands
O	**Taxus canadensis**	Rich woods and swamps
O	Rhamnus alnifolia	Bogs and swamps
	Myrica Gale	" " "
O	Vaccinium canadense	Sandy uplands
Y	Betula pumila	Bogs and swamps
O	Lonicera canadensis	" " "
O	**Arctostaphylos Uva-ursi**	Barren sands
O	Rosa sp.	Lake shores, etc.
	Spiraea latifolia	Swamps and meadows
O	Viburnum acerifolium	Rich woods and bluffs
	Decodon verticillatus	Swamps and marshes
	Andromeda glaucophylla	Open bogs
O	Aronia nigra	Bogs, etc.

(and about 15 others)

HERBS

Y	Pteris aquilina	Sandy uplands, etc.
Y	Typha latifolia	Marshes, etc.
Y	Chamaenerion angustifolium	Burns and clearings
	(Poa pratensis)	Roadsides, etc.
	Calamagrostis canadensis	Marshes
O	Aralia nudicaulis	Rich woods, shady bogs, etc.
O	Unifolium canadense	" " " " "
Y	(Solidago canadensis)	Fields and roadsides

* The sumacs of this region present a bewildering variety of forms, ranging from the perfectly smooth *R. glabra* to some almost pubescent enough to be called *R. typhina*; but no typical *R. typhina* was observed.

Y	(Asclepias syriaca)	Fields and roadsides
	(Achillea Millefolium)	" " "
	Scirpus validus	Lakes, etc.
	Carex filiformis	Bogs and marshes
Y	Dryopteris Thelypteris	" " "
O	**Gaultheria procumbens**	Sour soils, dry or moist
O	Cornus canadensis	Rich woods and bogs.
	Dulichium arundinaceum	Marshes, etc.
	(Verbascum Thapsus)	Pastures, roadsides, etc.
Y	Eupatorium purpureum	Swamps and meadows
O	Clintonia borealis	Rich woods and shady bogs
	Nymphaea variegata*	Quiet water
	Scirpus americanus	Lake shores, etc.
O	Rubus triflorus	Bogs and swamps
O	Vagnera racemosa	Rich woods
	Iris versicolor	Marshes
Y	Osmunda regalis	Swamps and marshes
Y	Scirpus cyperinus pelius	Marshes and meadows
	Comarum palustre	Marshes, etc.
Y	Eupatorium perfoliatum	Meadows, etc.
	Triadenum virginicum	Bogs and marshes
	Trientalis americana	Rich woods and shady bogs
Y	Asclepias incarnata	Marshes, etc.
O	Vagnera trifolia	Rich woods and shady bogs
O	**Chiogenes hispidula**	" " " " "
Y	Onoclea sensibilis	Marshes, etc.
	Lysimachia terrestris	" "
	(Pastinaca sativa)	Roadsides
O	**Mitchella repens**	Rich woods mostly
	Potentilla Anserina	Lake shores
	Carex arctata	Rich woods and bluffs
	Coptis trifolia	Rich woods and shady bogs
	Spartina Michauxiana	Lake shores, etc.
	Lathyrus palustris	" " "
Y	(Leptilon canadense)	Burns and waste places
	(Equisetum arvense)	Along railroads, etc.
O	**Linnaea americana**	Rich woods and shady bogs
Y	**Lycopodium annotinum**	" " " " "
	Lilium philadelphicum	Swamps and meadows
	Thalictrum dasycarpum	" " "
	(Chrysanthemum Leucanthemum)	Roadsides, etc.
	Danthonia spicata	Sandy uplands
	Equisetum palustre	Swamps and bogs
	Equisetum hyemale	Lake shores, etc.
X	(Cynoglossum officinale)	Roadsides
X	Washingtonia Claytoni	Rich woods
O	Actaea alba	" "

* For a discussion of the nomenclature of this plant, see Fernald & St. John, Rhodora **16**: 137–141. Aug. 1914.

	Mitella nuda	Rich woods and bogs
	Epigaea repens	Sour soils
	Campanula uliginosa	Marshes
	Equisetum fluviatile	"
O	Aralia racemosa	Rich woods
	(Convolvulus spithamaeus)	Sandy uplands
Y	Apocynum androsaemifolium	" "
	(Phleum pratense)	Roadsides, etc.
	Menyanthes trifoliata	Bogs and marshes
	Eleocharis palustris	Shallow water
O	Trillium grandiflorum	Rich woods
	Cladium mariscoides	Lake shores
Y	Eriophorum viridicarinatum	Bogs, etc.
O	**Oxycoccus macrocarpus**	Bogs
Y	(Apocynum cannabinum)	Ice ramparts, etc.
	Oryzopsis asperifolia	Sandy bluffs, etc.
X	Circaea alpina	Rich woods
X	(Arctium minus)	Waste places
Y	Euthamia sp.	Lake shores, etc.
	Equisetum laevigatum	" " "
	Botrychium virginianum	Rich woods
	Panicum depauperatum	Sandy uplands
	Equisetum scirpoides	Bogs
Y	Aster macrophyllus	Rich woods, etc.
	Scirpus atrovirens	Meadows, etc.
	(Ambrosia artemisiifolia)	Waste places
	Lobelia cardinalis	Along brooks
	Caltha palustris	" "
X	Galium triflorum	Rich woods
	Geranium Robertianum	" "
	(Trifolium pratense)	Roadsides, etc.
	(Trifolium repens)	" "
O	Polygonatum biflorum	Rich woods
	Naumburgia thyrsiflora	Marshes
	Comandra umbellata	Sandy uplands
Y	**Dryopteris spinulosa**	Rich woods
	Elymus sp.	Lake shores
	Phalaris arundinacea	" "
	Cypripedium hirsutum	Shady bogs

Summary.—The species above listed probably constitute something like nine tenths of the vegetation and one tenth of the flora of the region under consideration. About 275 additional species, nearly all herbs, were observed, but not often enough to be worth mentioning.

Not one of the large trees has fleshy or barbed fruits, while few of the smaller shrubs are wind-distributed. There are no barbed fruits on any of the woody plants, but a few of the small trees and

many of the shrubs, vines and herbs have fleshy fruits.* Herbs with barbed fruits are in this region chiefly confined to rich woods and roadsides, probably partly because of the exemption of such places from fire,† though it is not at present apparent why that should affect them more than it does the fleshy fruits. (Barbed fruits seem to be more characteristic of warmer climates and more calcareous soils, too.) Plants with erect capsules on stiff stems which stand up through the winter (called "tonoboles" by Clements‡) are much rarer here than a few degrees farther south, possibly because the snow interferes with their dissemination.

About half the large trees are evergreen, but none of the small trees, vines and large shrubs are, strange to say. It would seem from this that no evergreens except conifers (and one of those is deciduous) can stand the Michigan winters without the protection of snow.§ Vines are scarce, only two being listed, and those are not found much farther north.

The Ericaceae and allied families are largely represented among the small shrubs and evergreen herbs, as in many other places with similar climate. Other families pretty well represented in proportion to the total number of species in them, or the total flora of this region, or both, are Equisetaceae, Cyperaceae, Orchidaceae, Salicaceae, Rosaceae, and Caprifoliaceae, while the opposite might be said of the Fagaceae, Cruciferae (native), Caryophyllaceae (native), Leguminosae, Polygalaceae, Violaceae, Hypericaceae, Umbelliferae, Labiatae, Scrophulariaceae, and Lentibulariaceae, The sedges seem to be more numerous and also more abundant than the grasses.

Nearly all the species listed are widely distributed, extending from Nova Scotia to Minnesota at least, and most of them are represented in northern Europe by identical or closely related forms. Those peculiarly American plants which are confined to

* See Torreya **14**: 16. 1914.

† See Torreya **17**: 138–139. 1917. (In the text on page 138 *Allium* and *Deringa* were included inadvertently, and should be striken out.) Two additional references that should have been given there are: S. M. Coulter, Rep. Mo. Bot. Gard. **15**: 44. 1904; Harper, Torreya **10**: 60–61. 1910.

‡ Bot. Surv. Neb. **7**: 47. 1904.

§ In this connection see Gates, Torreya **12**: 257–262. 1912; Harper, Rep. Mich. Acad. Sci. **15**: 194. 1914.

the glaciated region and coastal plain or nearly so* are scarcely represented here, presumably because the climate is a little too cold.

A list of the commoner plants of the eastern part of the Upper Peninsula, based wholly on car-window notes, was published by the writer a few years ago.† In that a slightly different method of computation, which did not do justice to the conifers, was used, and the different sizes of trees and shrubs were not separated. But it is probably safe to say that *Abies*, *Picea canadensis*, *Betula pumila*, and *Andromeda glaucophylla* (to mention woody plants only) are more abundant in the Upper Peninsula than here; while the reverse is true of *Acer saccharum*, *Tsuga*, *Fagus*, *Tilia*, *Ulmus*, *Acer pennsylvanicum*, *Sambucus*, *Rhus glabra* (etc.), *Diervilla*, *Rubus strigosus*, *Comptonia*, *Rubus allegheniensis* (?), *Rhus Toxicodendron*, *Taxus canadensis*, and a few others, most of which are not evergreen.

Comparing this region with that adjoining it on the south we get a greater contrast, due to better soil and climate both. The commonest trees in the central third of lower Michigan (not counting the lake plains around Saginaw Bay, which are still more fertile), as determined from a few hours of car-window observations, seem to be as follows:

Quercus velutina (?), *Pinus Banksiana*,‡ *P. Strobus*, *Ulmus americana*, *Larix laricina*, *Quercus borealis maxima* (?), *Acer saccharum*, *Fagus*, *Thuja*, *Tsuga*, *Abies*, *Tilia*, *Pinus resinosa*, *Quercus alba*, and *Picea mariana*.

Still farther south the change in composition of vegetation continues in the same direction, and in extreme southern Michigan nearly all the trees are deciduous.

COLLEGE POINT,
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* See Rhodora **7**: 69–80. 1905; **8**: 27–30. 1906.

† Rep. Mich. Acad. Sci. **15**: 193–198. 1914.

‡ If I had left northern Michigan by way of the Michigan Central R. R. instead of the Pere Marquette, *Pinus Banksiana* would doubtless have stood higher in the first list and lower in the one on this page; for along the former railroad it is said to be abundant in Crawford and Roscommon Counties, while along the latter I saw it mostly in Lake and Newaygo Counties, south of the limits assigned in this paper. (See second map between pages 550 and 551 of the 9th volume of the Tenth Census.)